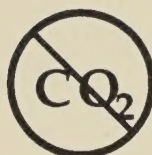
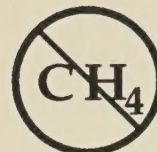
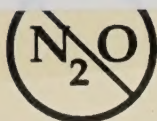


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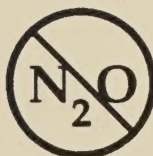
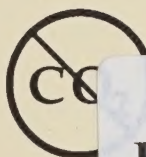
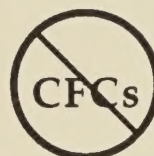
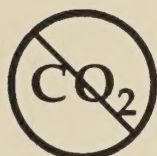
Canada. AES. Canadian Climate Centre. Greenhouse Gas
Miser Committee.
GREENHOUSE GAS MISER HANDBOOK. / Krajnc, Anita;
Hengeveld, Henry 1993.

Prof. Munro
Many thanks
Anita

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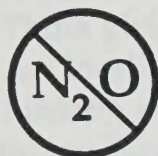
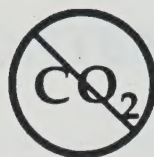
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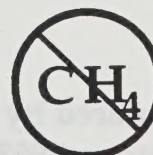
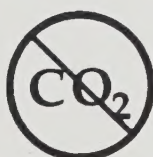
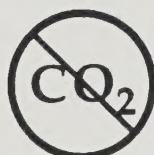
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Greenhouse Gas Miser Committee
Canadian Climate Centre

Prepared by Anita Krajnc and Henry Hengeveld
January 1993
First Edition



GREENHOUSE GAS MISER HANDBOOK



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Greenhouse Gas Miser Committee
Canadian Climate Centre

CONTENTS

Acknowledgements	2
About This Handbook	3
Greenhouse Gas Miser Attitudes	4
Think globally	4
Act locally	7
Linking attitude and actions: a personal CO ₂ inventory	8
Greenhouse Gas Miser Actions	16
Menu	16
At home	18
On the road	36
At work	39
In communities	43
References	44

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Henry Hengeveld
Anita Krajnc

Prepared by Anita Krajnc and Henry Hengeveld
January 1999
First Edition

About This Handbook

This handbook is about attitudes and actions.

The first part is about thinking like a greenhouse gas miser. It's about understanding the issues--the consequences of global warming, the sources of greenhouse gas emissions and how the individual fits in. It includes a worksheet to help you calculate your personal carbon dioxide emissions (the main greenhouse gas). With the big picture in hand, the next step is translating attitudes into actions.

The second part is about acting like a greenhouse gas miser. It lists hundreds of things you can do. It's about putting our own house in order (Should I get a solar water heater?), starting in our own backyard (How much of a difference does composting make?), and leading by example (on the road, in communities, and at work). It lists actions and quantifies the advantages in terms of reduced greenhouse gas emissions, other environmental benefits and money savings.

The purpose of this handbook is to get individuals to think about the many roles they can play in protecting the global environment and to make changes whether small or major lifestyle ones. If all 27 million Canadians make changes in those activities that create greenhouse gases, it will make a big difference for Canada and the world. See the References at the back of the handbook for more information on global warming and taking preventive action.

GREENHOUSE GAS MISER ATTITUDES

The World Commission on Environment and Development (or "Brundtland Commission") defines sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs"¹ Our greenhouse gas emissions, caused by our present patterns of energy use and other activities, is not sustainable. The resources of the Earth and its ability to absorb our wastes are not limitless. While the Brundtland Commission writes about "a global agenda for change," another key part of the solution involves individuals like you and me. We need to become greenhouse gas misers and develop a **personal agenda for change**.

THINK GLOBALLY

Where do we start? The first step we can take is to change our way of thinking about our planet's ecosystem, our fellow humans and ourselves. We need to think globally--it gives us a host of reasons to act locally. Here are three factors based on the concept of sustainable development that help form a greenhouse gas miser's global perspective:

1. Interlocking Crises

Greenhouse gas miser actions can help solve many environmental problems at the same time. "Environmental stresses are linked one to another," notes the Brundtland Commission, "... And success in one area, can improve chances of success in another area."² Global warming is caused mainly by fossil fuel use and deforestation. Reducing fossil fuel use can also help reduce more immediate environmental problems such as urban smog, acid rain, and toxic chemical pollution. Reducing deforestation not only protects a valuable carbon dioxide "sink", but also a habitat for plant and animal species. The elimination of chlorofluorocarbons (CFCs), also greenhouse gases, will help stop the weakening of the protective stratospheric ozone layer.

2. Future Generations

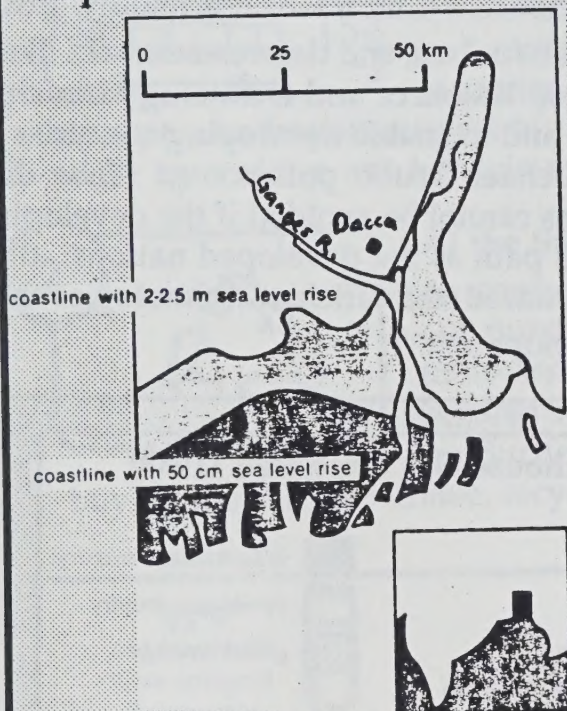
Global warming poses a threat to future generations. Human activities have already caused the amount of carbon dioxide equivalent in the atmosphere to increase by as much as 50% since preindustrial times. For "business-as-usual"

¹World Commission on Environment and Development, *Our Common Future* (Oxford: Oxford University Press, 1987)

²Ibid., p. 37.

scenarios, this could double by 2030 and quadruple by 2100.³ Many of the consequences of global warming are long term (see box below). Instead of borrowing from our children's future, we need to keep greenhouse gas emissions in the atmosphere within safe limits (1) to allow ecosystems to adapt naturally to climate change, (2) to ensure that world food production is not threatened, and (3) to enable sustainable economic development--the stated objectives of the international climate treaty signed by 154 countries at the Earth Summit in June 1992.

Impacts



Projected flooding in Bangladesh due to sea level rise

Source: G. McKay and H. Hengeveld, "The Changing Atmosphere," in C. Mungall and D. McLaren, (eds) *Planet Under Stress* (Oxford, Oxford University Press, 1990)

Some of the consequences of global warming are potentially positive. For example, the direct effects of higher CO₂ levels on plants can be beneficial for improved growth and drought tolerance. Warmer temperatures will improve growing seasons in cooler climates, while making polar regions more accessible to marine transportation. However, there is great cause for concern in other areas. With almost 50% of the world's human population located along the ocean's coastlines, the possibility of between 30 and 110 centimetre rise in sea levels by 2100 has very ominous implications, particularly for low-lying countries such as Bangladesh, Egypt, the Maldives and the Netherlands. Redistribution of rainfall will decrease drought stress in some areas while turning others into deserts, dramatically changing the global pattern of food production and distribution. Slow forest response to climate shifts may result in large-scale dieback along the warm margins of current ecosystems. Heat stress, increased disease, decreased water quality and more frequent severe tropical storms could have major implications for human health and natural ecosystems. The greatest concern is that the rapidity of climate change may make adaptation particularly difficult.

3. Global Equity

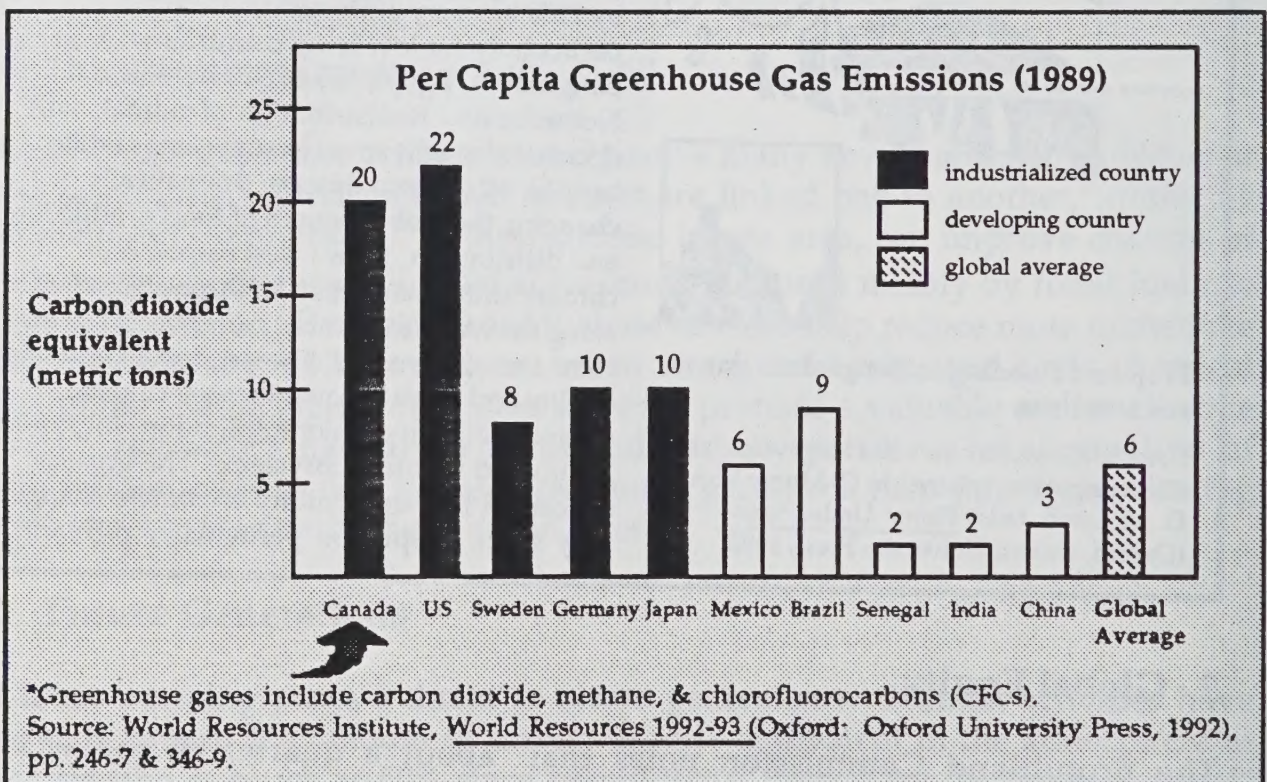
The Brundtland Commission notes that "about a quarter of the world's population consumes three-quarters of the world's primary energy."⁴ The same is true for greenhouse gas emissions. The figure below shows the differences in

³J. T. Houghton et al. (ed), *Climate Change: IPCC Scientific Assessment* (Cambridge: Cambridge University Press, 1990)

⁴World Commission on Environment and Development, p. 169.

emission levels around the world. Per capita emissions in affluent industrialized countries are much higher than in developing countries. Canada's per capita emissions are particularly high. They are about twice that of Western Europe and Japan, three and half times the global average, and ten times that of Senegal and India. While there are climatic, geographic and economic reasons for high per capita emissions in Canada,⁵ another very important reason is our affluent and often wasteful lifestyle.

On the other hand, developing countries not only have contributed least to past and present emissions, but they are also more vulnerable to global climate change. However, if the world population increases and stabilizes at between 8 and 14 billion next century and as the world's \$13 trillion world economy grows 5-10 fold in the next half century,⁶ then fossil fuel use and deforestation are likely to increase rapidly in developing countries. Resource and technology transfers are necessary to meet global human needs and to enable developing countries to pursue alternative energy paths. As Michael Grubb points out: "The dire prediction of future global carbon emissions cannot be avoided if the developing nations industrialize along the same broad path as the developed nations: they will have to 'leapfrog' directly to more advanced and efficient technologies than would occur naturally in the course of development."⁷



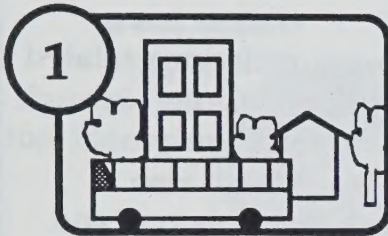
⁵Government of Canada, *Canada and Global Warming: Meeting the Challenge*, 1992.

⁶World Commission on Environment and Development, p. 4.

⁷Michael Grubb, "The greenhouse effect: negotiating targets," *International Affairs*. Vol. 66, No. 1, January 1990, pp. 67-89.

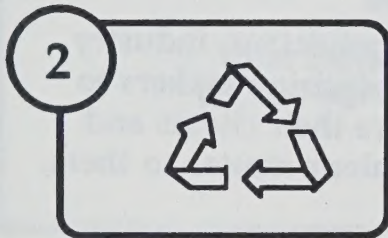
ACT LOCALLY

Thinking globally gives us a number of reasons to act locally. Most important are individual values like taking responsibility for our own actions. As environmental citizens we can play many roles in reducing Canada's greenhouse gas emissions.



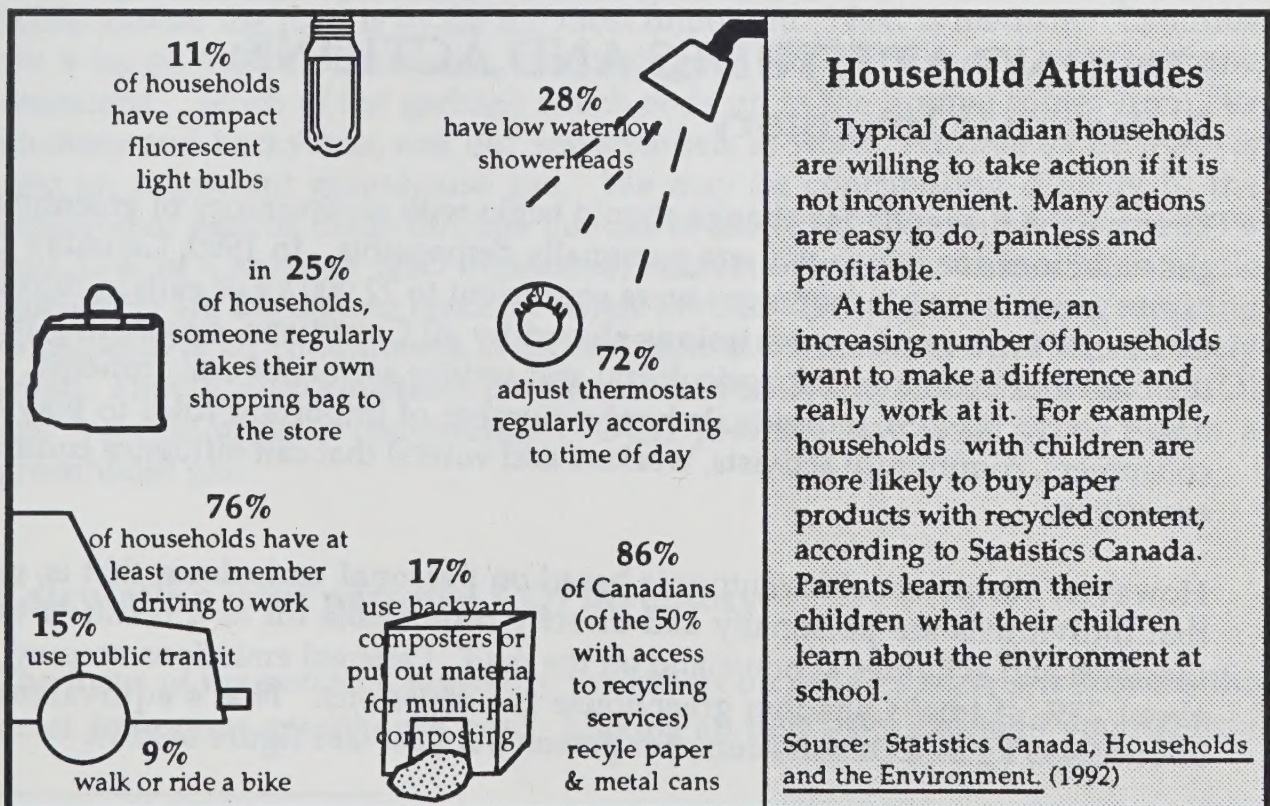
At Home and On the Road

We need to evaluate how our daily actions at home and on the road affect the environment. While it is far easier to suggest that others - government, industry and commerce within our country, or people of other countries - should take action, we ourselves are not exempt. An important part of the solution is putting our own house in order by making our behaviour and lifestyle more environmentally-friendly.



At the Store

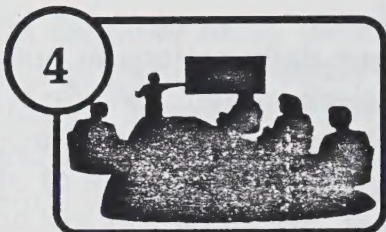
As consumers we can influence manufacturers through our purchasing habits. We can avoid overpackaged or unnecessary purchases, and seek out products that involve minimum environmental damage during production. We can also contribute to the 3 Rs by buying durable, repairable, recycled and recyclable goods.





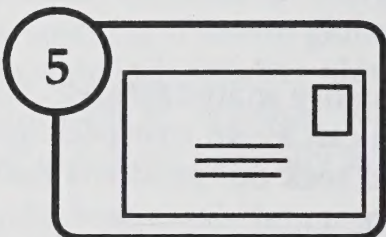
In Communities

We can take positive steps in our community centres, join an environmental group, encourage environmental learning in schools, and support sustainable development projects in developing countries.



At Work

We can reduce greenhouse gas emissions related to work activities. We can limit emissions through individual actions like turning off equipment not in use, and applying the 3Rs. We can also encourage management to make decisions and take actions that are good for the environment.



In Decision-Making Circles

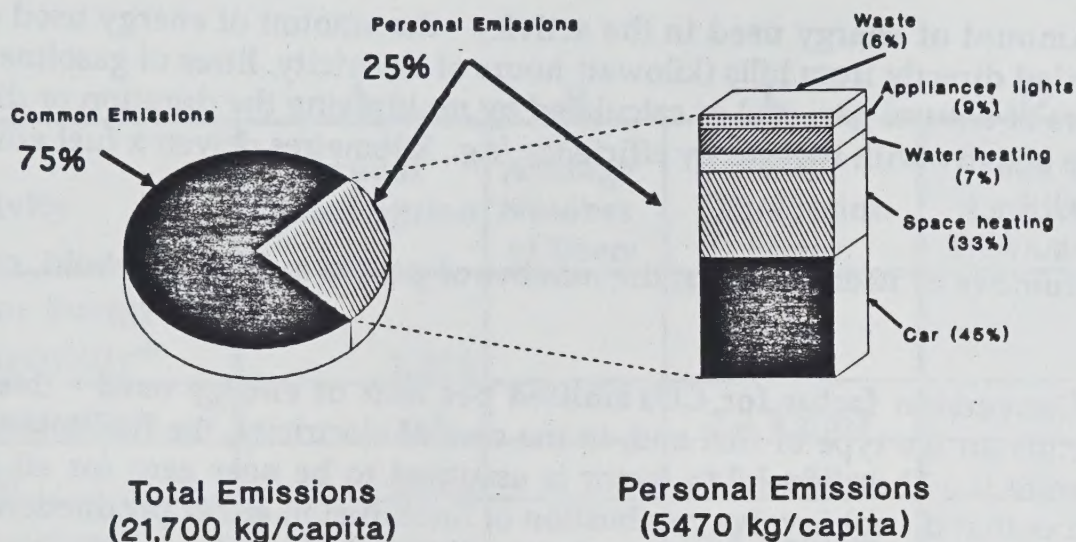
We can speak or write to politicians, industry representatives and other decision-makers to voice our concerns. We are their clients and constituents, and our opinions matter to them.

LINKING ATTITUDES AND ACTIONS: A Personal Inventory

Your **personal agenda for change** should begin with an inventory of greenhouse gas emissions for which you are personally responsible. In 1990, Canada's per capita greenhouse gas emissions were equivalent to 22,000 kg of carbon dioxide. Of this, 3/4 are **common emissions** shared by all Canadians, originating from the industrial, commercial, agricultural and service sectors of our economy. As noted above (#s 2-5), individuals have a number of important roles to play (as consumers, community activists, workers and voters) that can influence common emissions.

However, our personal inventory is based on **personal emissions**, that is, ones that individuals are personally and directly responsible for as a result of their lifestyles and activities at home and on the road. Personal emissions account for about 25% of total Canadian greenhouse gas emissions. **That's equivalent to about 5,435 kg of CO₂ emissions per person per year** (see figure below).

Canada's Per Capita Breakdown of Personal and Common Greenhouse Gas Emissions (1990)



Of our personal greenhouse gas emissions, carbon dioxide from energy use at home and on the road is by far the most important. Next is methane. Landfills are a major source of methane, accounting for 38% of Canada's total methane emissions. Much of the garbage which ends up in the dumps comes from our kitchens and backyards, and our wastebaskets at work. Nitrous oxide (N₂O) is also an important greenhouse gas. We may be contributing directly to the emission of nitrous oxide through our use of motor vehicles and fertilizers (33% and 17% of Canadian N₂O emissions, respectively). For cars, old catalytic converters are the biggest concern. There are also CFC emissions from servicing or disposal of air conditioners, refrigerators, and freezers, but these are relatively small. Finally, auto emissions of nitrogen oxides (NO_x), carbon monoxide (CO) and volatile organic compounds (VOCs) produce low level ozone - also a greenhouse gas.

Calculating your personal CO₂ inventory

The focus of the personal inventory worksheet on page 11 is carbon dioxide, the most important greenhouse gas.⁸ Making an inventory can help you identify

⁸While other greenhouse gases (methane, nitrous oxide, etc.) are important, they are much more difficult to calculate.

which of your own activities are the biggest contributors to CO₂, and hence where you could start being a greenhouse gas miser.

Three factors need to be considered in calculating the carbon dioxide emissions associated with an activity. These are:

A. Amount of energy used in the activity - the amount of energy used can be recorded directly from bills (kilowatt-hours of electricity, litres of gasoline, cubic meters of natural gas, etc.) or calculated by multiplying the duration or distance of the activity with the energy efficiency (e.g., kilometres driven x fuel efficiency of car);

B. Number of users - that is, the number of people in the household, carpool, etc.

C. Conversion factor for CO₂ emitted per unit of energy used - this factor depends on the type of fuel and, in the case of electricity, the fuel mix used to generate it. The conversion factor is assumed to be near zero for all energy sources that do not involve combustion of fossil fuel in either production or use of the energy (e.g., biomass, solar, wind, hydro, nuclear, etc.).

Carbon dioxide emissions can then be calculated as follows:

$$\text{Personal CO}_2 \text{ Emissions} = \frac{\text{Energy Used} \times \text{Conversion Factor}}{\text{Number of People}}$$

WORKSHEET*

Calculate Your Personal CO2 Inventory

	A	B	C	D
Activity	Annual Consumption	Average Number of Users	CO2 Conversion Factor	Total CO2 Emitted (kg) $D = (A/B) \times C$
Home Energy Use				
Electricity**	kWh			
Natural gas	m ³		2.2 kg/m ³	
Oil	litres		3.0 kg/litre	
Gasoline	litres		2.5 kg/litre	
(other)				
Transportation				
(gasoline)				
Car	litres		2.5 kg/litre	
(alternative fuel)				
Public transit	km	n/a	0.04 kg/km	
Air travel	km	n/a	0.25 kg/km	
Railway	km	n/a	0.17 kg/km	
Total Annual Personal Carbon Dioxide Emissions*** (add figures in column D)				

*Based on worksheet by J. DeCicco et al., CO2 Diet for a Greenhouse Planet: A Citizen's Guide for Slowing Global Warming (National Audubon Society, 1990)

**Use the electricity conversion factor for your province/territory as listed in the table on page 13.

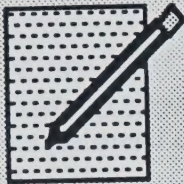
Sample Inventories

(a) for a family of 3 living in an apartment using mainly public transit:

Activity	A Annual Consumption	B Average Number of Users	C CO2 Conversion Factor	D Total CO2 Emitted (kg) $D = (A/B) \times C$
Home Energy Use				
Electricity	10,000 kWh	3	0.22 kg/kWh	733
Natural gas	m ³		2.2 kg/m ³	
Oil	litres		3.0 kg/litre	
Gasoline	litres		2.5 kg/litre	
Transportation (gasoline)				
Car	600 litres	3	2.5 kg/litre	500
Public transit	7,000 km	n/a	0.04 kg/km	280
Air travel	km	n/a	0.25 kg/km	
Railway	2,000 km	n/a	0.17 kg/km	340
Total Annual Personal Carbon Dioxide Emissions (add figures in column D)				1,853 kg of CO₂

(b) for a family of 3 living in a detached suburban house and commuting to work:

Activity	A Annual Consumption	B Average Number of Users	C CO2 Conversion Factor	D Total CO2 Emitted (kg) $D = (A/B) \times C$
Home Energy Use				
Electricity	5,300 kWh	3	0.22 kg/kWh	389
Natural gas	3,360 m ³	3	2.2 kg/m ³	2,464
Oil	litres		3.0 kg/litre	
Gasoline	litres		2.5 kg/litre	
Transportation (gasoline)				
Car	2,400 litres	3	2.5 kg/litre	2,000
Public transit	km	n/a	0.04 kg/km	
Air travel	2,000 km	n/a	0.25 kg/km	500
Railway	km	n/a	0.17 kg/km	
Total Annual Personal Carbon Dioxide Emissions (add figures in column D)				5,353 kg of CO₂



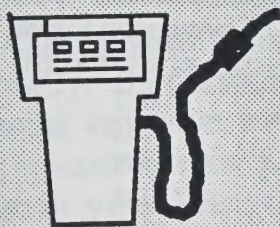
Filling Out the Worksheet

Column A: Consumption

Home Energy Use

Use last year's utility bills to determine your total home energy use. If your utility costs are included in your rent, ask your landlord or landlady for an estimate of the total amount of energy consumed in your building, and divide by number of households in the building. If you are unable to get these numbers, use the average annual figures for apartments: 10,000 kWh of electricity or 1,430 litres of oil or 1,490 cubic metres of natural gas for space and water heating, and 4,440 kWh of electricity per year for appliances and lighting.

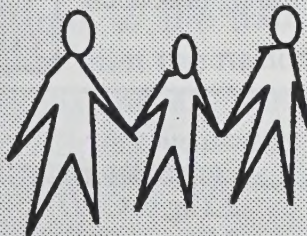
Transportation



Estimate the amount of fuel consumed for automobile travel. One way to calculate fuel consumption is by multiplying distance travelled with automobile fuel efficiency. You can estimate your auto fuel efficiency by measuring fuel use per kilometre of travel for several fill-ups. Alternatively, you can use the ratings provided by Transport Canada's annual Fuel Consumption Guide for the make and year of your vehicle; however this rating will not reflect the operating condition of your vehicle or your personal driving habits.

For other modes of transit, consumption is expressed in total kilometres travelled, rather than quantity of fuel. For public transit, estimate how much of your travel was on the subway or street cars, on buses and on trains.

Column B: Number of Users



Home Energy Use

In column B, fill out the number of people living in your household. If some people lived there only part of the year, estimate the fraction of the year involved. For example, if three people lived in your household all year and one additional person lived there for three months, the number of occupants is 3.25.

Transportation

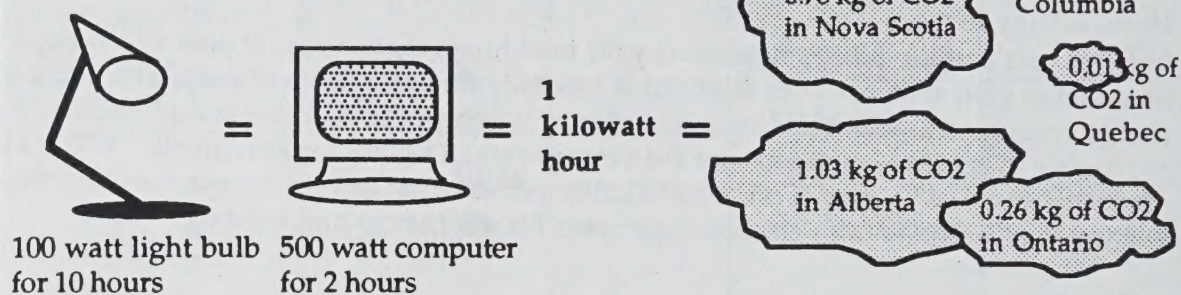
For automobile use, the average number of users is equal to the average number of occupants in the vehicle per trip. If you travel in a carpool with others, use the number of people in the vehicle as your occupancy value. For public transit, train and air travel, leave Column B blank since this number is included in the conversion factor used.

Column C: Conversion factors*

Home Energy Use

The CO₂ emitted per kWh used varies significantly from province to province. Use the table below to find the electricity CO₂ conversion factor for your province or territory, and fill it in Column C of the Worksheet.

The Plug on CO₂ Emissions



Provinces that rely heavily on fossil fuel-generated electricity (e.g., Nova Scotia, Saskatchewan and Alberta) have high CO₂ conversion factors for electricity compared to those that use mostly hydro and other non-CO₂ polluting fuels (e.g., Quebec, Manitoba and British Columbia). However, note that fuels have other environmental, social and economic costs and risks associated with them beyond their costs in terms of greenhouse gas emissions.

Also, conversion factors may be significantly higher for use of electricity during peak hours (e.g. Ontario).

Electricity CO₂ Conversion Factors (1990)

Province/Territory	Conversion Factor (kg of CO ₂ /kWh)
Newfoundland	0.17
Prince Edward Island	0.15
Nova Scotia	0.78
New Brunswick	0.46
Quebec	0.01
Ontario	0.26
Manitoba	0.03
Saskatchewan	0.88
Alberta	1.03
British Columbia	0.02
Yukon/Northwest Territories	0.32
Canadian Average	0.22

Home Energy Continued

Fuel	Conversion Factor (including upstream emissions)
Natural Gas	2.2 kg of CO ₂ /m ³
Furnace Oil	3.0 kg of CO ₂ /litre
Propane	1.6 kg of CO ₂ /litre or 3.2 kg of CO ₂ /kg

Transportation

Mode	Fuel	Conversion Factor
Automobile	Gasoline	2.5 kg CO ₂ /litre
	Diesel	2.9 kg CO ₂ /litre
	Propane	1.6 kg CO ₂ /litre
	Natural Gas	2.7 kg CO ₂ /kg
Public Transit		0.04 kg CO ₂ /passenger-km
Train		0.17 kg CO ₂ /passenger-km
Airplane		0.25 kg CO ₂ /passenger-km

*See references at back

Using Your Inventory

There are a lot of things you can do with your personal CO₂ inventory! Here's just four of them:

- 1. Use the personal CO₂ inventory as an educational tool.** Completing your personal CO₂ inventory can be an awareness-raising exercise. Who ever thought that consuming 1 litre of gasoline driving a car say 10 kilometres on the highway releases 2.5 kilograms of carbon dioxide into the atmosphere, or that space heating is a major source of CO₂ emissions at home? With the inventory, it's easy to make the connection between such end use activities and global warming.
- 2. Use your inventory to help you identify areas on which to focus your greenhouse gas miser actions.** Assess the relative importance of your various activities at home and on the road to your greenhouse gas inventory. This information can help you select areas where you can most effectively reduce your greenhouse gas emissions.
- 3. Assess your emission trends by completing a personal CO₂ inventory annually.** By periodically recording your personal total CO₂ emissions, you can examine emission trends, and assess the results of your efforts. However, note that emissions may jump inadvertently as, for example, you move to a different stage in your lifecycle (e.g., when starting a family). Alternatively, personal emissions may fall as families mature, dependents leave home and needs change, even without an attempt to minimize such emissions. The key is to try to control emissions, to minimize any increases and to maximize decreases. In other words, focus on actions.
- 4. Compare your personal emissions to the national average.** Are your personal emissions significantly higher than the national average? If so, what factors account for your high emissions and are there actions you can take to significantly reduce your emissions? Or are your emissions relatively low? In this case, contemplate actions you can take to continue this happy circumstance from a greenhouse gas miser's perspective!

GREENHOUSE GAS MISER ACTIONS

MENU

Be a Greenhouse Gas Miser at Home!

1. Selecting a Home.....	18
a) housing type.....	18
b) housing location.....	18
c) energy efficiency.....	18
2. Home Heating and Cooling.....	19
a) thermal envelope improvement	20
b) draftproof and insulate.....	20
c) windows and doors.....	21
d) plant trees.....	22
e) temperature setting.....	24
f) heating systems.....	24
g) summer cooling.....	28
3. Water Heating.....	29
a) energy efficient showerheads.....	29
b) washing clothes.....	29
c) water heating systems.....	29
4. Appliances.....	31
5. Lighting.....	33
6. Waste Reduction.....	34
a) reduce, reuse & recycle.....	34
b) compost.....	35

Be a Greenhouse Gas Miser on the Road!

7. Transportation Modes.....	36
a) walk or ride a bike.....	36
b) mass transit.....	36
c) carpool.....	36
8. The Automobile.....	36
a) buying a new car.....	37
b) maintenance.....	37
c) driving habits.....	38

Be a Greenhouse Gas Miser at Work!

9. Office Building.....	39
a) energy audit.....	39
b) heating.....	39
c) motors.....	39

10. Work Station.....	40
a) lighting.....	40
b) waste reduction.....	41
c) office equipment.....	41
d) purchasing.....	41
11. Work Related Travel.....	41
a) alternative transportation.....	41
b) parking.....	42
c) vehicle requisition.....	42
d) business travel.....	42

Be a Greenhouse Gas Miser in Your Community!

12. Community Action.....	43
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Be a Greenhouse Gas Miser at Home!

1. Selecting a Home

When it comes to buying or renting a home, greenhouse gas emissions per household vary according to the housing type, housing location and the energy efficiency of the building.

Housing Type

Apartments typically require about two thirds less total energy per unit than single and semi-detached houses due to their lower heating requirements. Row houses use one quarter less energy compared to detached houses.⁹ In addition, the smaller the floor space, the lower the energy consumption and the greater the number of persons in the household the lower the per capita energy use.

Housing Location

Consider living close to work, school and activities. It can greatly reduce your need for daily commuting. Also, look for locations with good access to public transit.

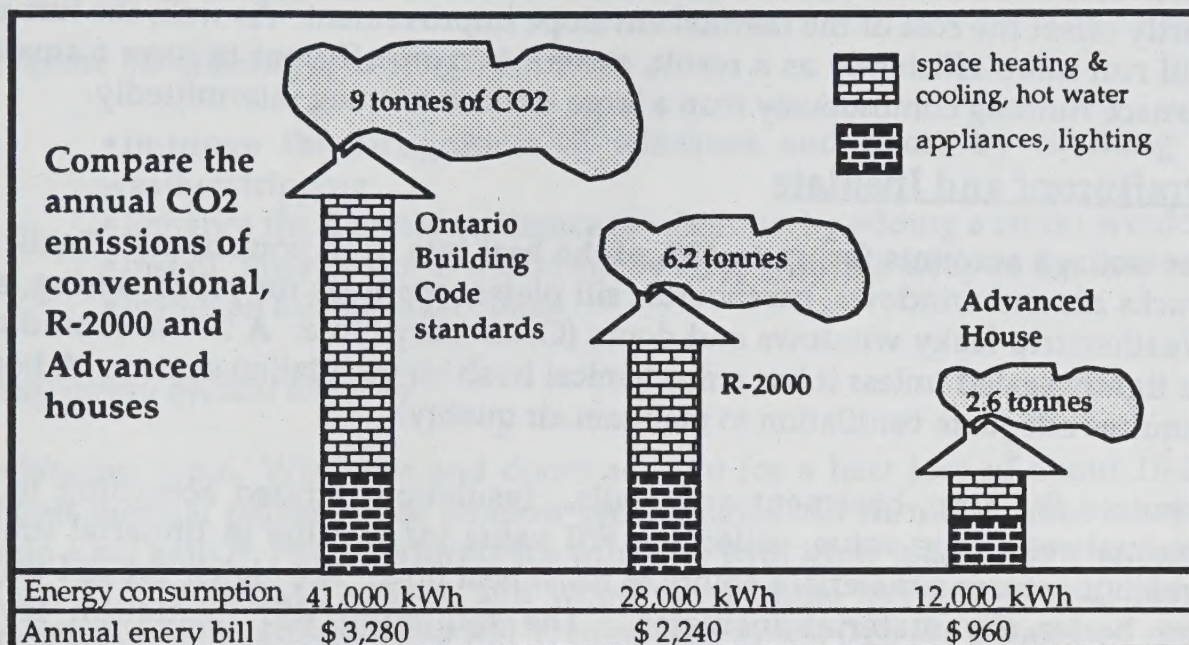
Energy Efficiency

When buying a house, ask about the energy efficiency of the house. Look for homes with a R-2000 home identification certificate. R-2000 is an energy efficiency standard for new homes under a voluntary government-industry program. It consists of an integrated package of upgrades including high insulation levels, air tightness, heat recovery ventilation and efficient heating systems. As a result, R-2000 homes use only two thirds the energy of a conventionally built home.

Even more efficient is the Advanced House built in Brampton, Ontario, as a demonstration project. It uses about a quarter of the energy of a traditional house. The Advanced House features high-performance windows, a two-storey passive-solar sun space, an integrated mechanical system with a heat pump that recovers heat from grey water, ventilation exhaust and excess solar gains, a thermal storage system, energy efficient appliances, and all-fluorescent lighting.

⁹Ontario Global Warming Coalition, *Degrees of Change: Steps Towards an Ontario Global Warming Strategy* (Prepared for the Ontario Ministry of Energy and the Ontario Ministry of the Environment, June 1991)

As shown in the figure below, compared to typical housing, the R-2000 and Advanced houses emit 32%-73% less carbon dioxide. Over time energy efficient homes save money too with lower operating costs offsetting higher capital costs.



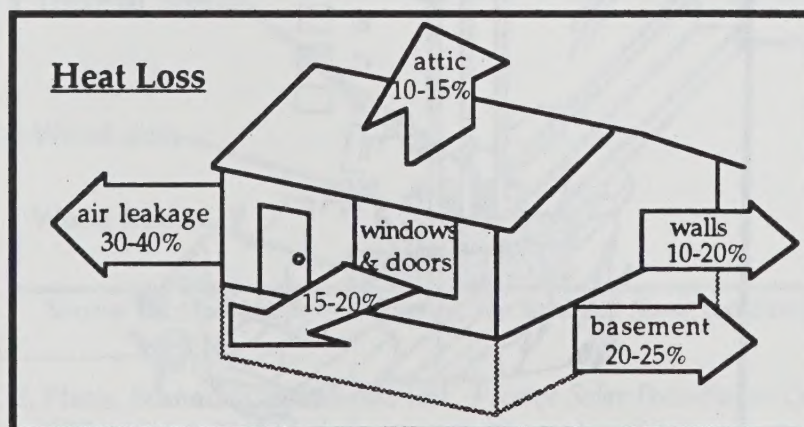
Based on the assumptions that the houses are electrically heated with a floor space of 3100 square feet, the electricity rate is \$0.08/kWh and Canada's CO2 emissions rate is 0.22 kg of CO2/kWh.

Ontario Ministry of Energy, The Advanced House, no date.

2. Home Heating and Cooling

Space heating on average consumes about two thirds of our home energy use and accounts for about **5 metric tons of CO2** emissions per household each year. This makes space heating a great place to start being a greenhouse gas miser.

The figure below illustrates the most common areas of heat loss.



(Source: Ontario Hydro, "Electric Heating," 1991)

Thermal Envelope Improvement

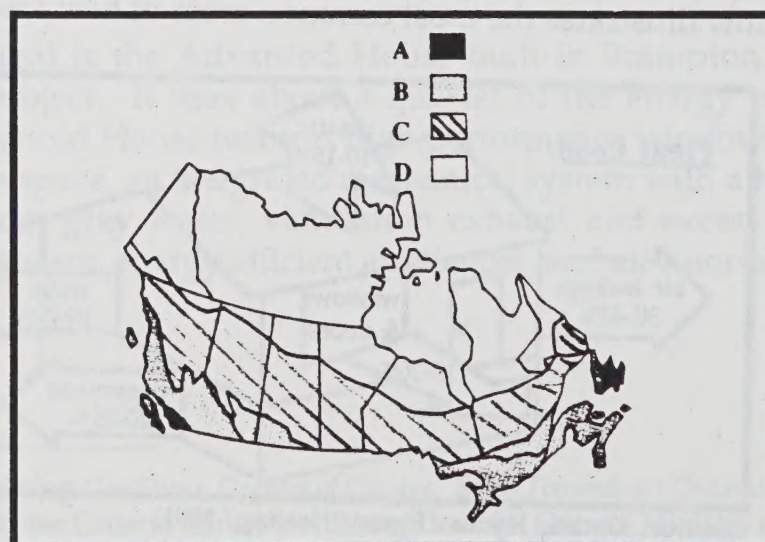
If you plan to make a thermal envelope improvement (insulation, caulking, windows, etc.) and put in a new furnace, do the thermal envelope improvements first. The furnace can then be downsized and savings on the furnace cost can partly offset the cost of the thermal envelope improvement. As well, the furnace will run more efficiently as a result, since it is more efficient to have a smaller furnace running continuously than a large furnace running intermittently.

Draftproof and Insulate

Air leakage accounts for up to 40% of the heat loss from your home. Caulk all cracks around windows, baseboards, sill plates, openings for pipes, wiring, etc. Weatherstrip leaky windows and doors (Cautionary Note: A house should not be tightly sealed unless it has a mechanical fresh air ventilation system. A home requires adequate ventilation to maintain air quality).

Insulate the attic, basement and walls. Insulation is rated according to its thermal resistance value, called the RSI value (or R-value in Imperial units), which measures a material's ability to resist heat flow. The higher the RSI value, the better the material insulates. The minimum RSI insulation levels recommended for the retrofit of existing homes vary according to geographical location.

		Geographical Zones			
		A	B	C	D
walls	RSI	3.0	3.6	4.1	4.5
	R	17	20	23	13
basement walls	RSI	2.2	2.2	2.2	2.2
	R	13	13	13	13
roof or ceiling	RSI	4.5	5.6	6.4	7.1
	R	26	32	36	40
floor (over unheated spaces)	RSI	4.7	4.7	4.7	4.7
	R	27	27	27	27



Energy, Mines and Resources, *Keeping the Heat In* (1990)

Consider using recycled, renewable and nontoxic insulation materials such as saw dust, wood shavings and cellulose fibre made from recycled newspaper.

Windows and doors:

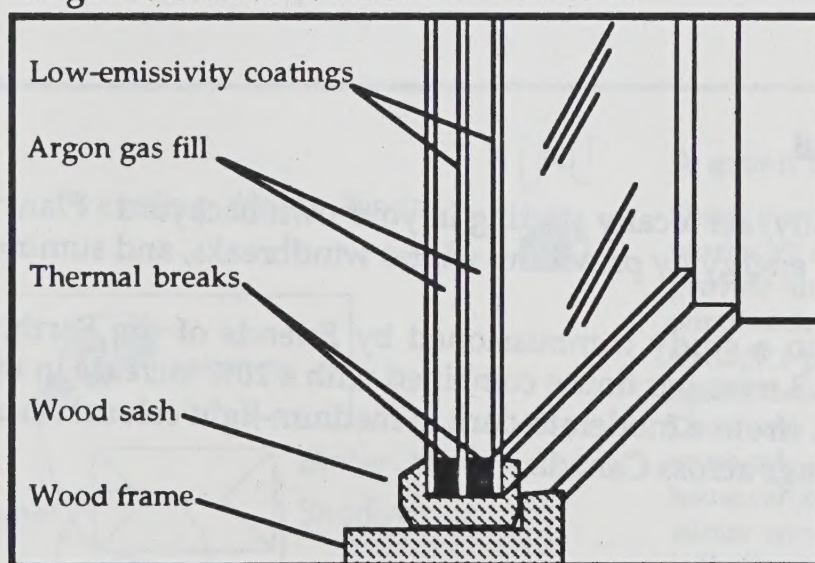
Improve the efficiency of existing windows

- Improve the airtightness of windows and doors by caulking and weatherstripping.
- Enhance the thermal resistance of windows by adding a storm window.
- Install "interior storm windows" by adding shrink wrap to the interior.
- Install an acrylic inner sheet.

Buy energy efficient windows

• *Window types.* Windows and doors account for a heat loss of about 15-20%. High thermal performance window technologies can turn this from a net loss into a net gain.¹⁰ High-performance windows with triple glazing, low-emissivity (low-E), argon filled spaces, and wood-vinyl frame have an overall thermal resistance value approaching RSI 1, compared to RSI 0.36 for a standard double glazed window. High performance windows initially cost more than standard double glazed windows but the payback is less than 4 years for an electrically heated house and 8 years for natural gas homes.¹¹ Check for utility and government grant programs that shorten payback periods.

High Performance Thermal Windows



Source: Ontario Ministry of Energy, *The Advanced House* (no date)

¹⁰Parekh, A., R. E. Platts, Scanada Consultants Ltd. *Passive Solar Potential in Canada: 1990-2010*. DSS Contract No. 695Z.23216-8-9043. Efficiency and Alternative Energy Branch, Energy, Mines and Resources Canada, Ottawa, Ontario, 1990.

¹¹*Ibid.*, p. 24.

- *Window styles.* The most energy efficient are fixed windows because there is less opportunity for air leakage. Next, hinged windows are more efficient than sliding ones since they can be tightly shut with a compression seal.

- *Window frames.* Solid wood and clad wood frames have high insulation values. Aluminum, on the other hand, conducts heat quickly so use a thermal break.

The table below shows the CO₂ savings potential of high thermal performance windows compared with standard double glazed.

Buy Energy Efficient Windows

Type of window	Annual energy saving potential (kWh/m ²)	Annual dollar savings (\$/m ²)	Annual CO ₂ savings (kg/m ²)
Standard double	base	base	base
Super double (low-e coating, argon gas filled & butyl-metal spacer in wood frame)	161	12.88	35
Standard triple	91	7.28	20
Super triple (low-e coating, argon gas filled & butyl-metal spacer in wood frame)	193	15.44	42

Chart assumes electric space heating and cooling, power costs 8 cents/kWh, and Canada's CO₂ emission rate is 0.22 kg of CO₂/kWh. Based on Parekh and Platts, 1990: pp. 22-23.

Plant Trees

Think globally, act locally starting in your own backyard. Plant trees! Trees can save a lot of energy by providing winter windbreaks, and summer shade.

According to a study commissioned by Friends of the Earth, the "tree-house effect" from 3 trees per house combined with a 20% increase in the surface albedo of buildings (from a moderate-dark to medium-light colour) results in substantial energy savings across Canada:

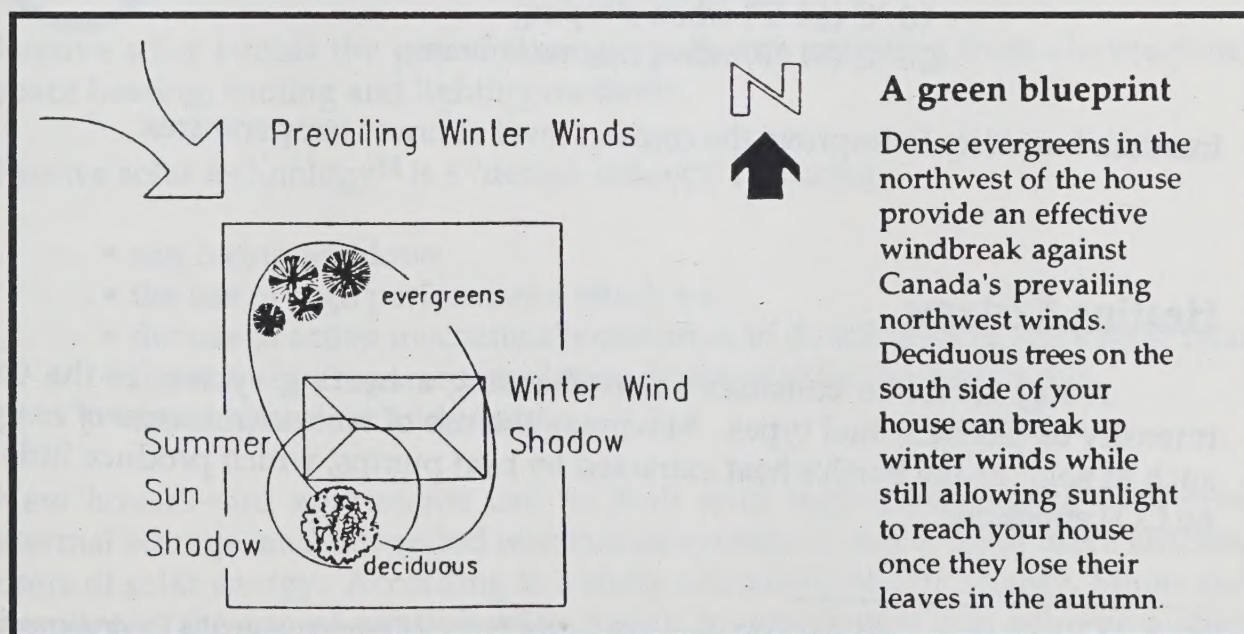
The "Treehouse Effect"

Location	Heating energy savings (%)	Cooling energy savings (%)	Annual CO ₂ savings (kg)
Toronto urban residential	10	40	740 to 1,730
open rural	20	30	1,320 to 3,040
Montreal	11	35	40 to 1810
Edmonton	8	100	1,090 to 2,070
Vancouver	10	100	50 to 1,110

Low values are for new, all-electric homes in Montreal and Vancouver and gas-heated homes in Toronto and Edmonton. High values are for old houses with conventional gas funaces in Edmonton and oil furnaces in Montreal, Toronto and Vancouver.

Source: Hashem Akbari and Haider Taha, The Tree-House Effect: The Impact of Trees and White Surfaces on Residential Energy Use in Four Canadian Cities. (Ottawa: Friends of the Earth, July 1991)

In the winter, trees can reduce your home's air leakage and heating requirements by redirecting winds away from your home and slowing down windspeeds. Check the wind direction where you live to determine where to plant evergreen windbreaks. You can do it yourself by watching the direction trees sway or flags blow for a few hours over several months. Or simply call your weather office. The diagram below provides a blueprint for planting trees in areas with prevailing northwest winds.



Source: Ontario Ministry of Energy, R-2000 Design Handbook, 3rd ed. (1990)

In the summer, trees can greatly reduce your cooling needs. Tall, leafy deciduous trees on the south, east and west sides of your house can provide direct shade for your home. Trees and shrubs also cool the microclimate so that cooling units don't have to work as hard as they take in cooler air. Friends of the Earth note that "A tree over the air conditioner may be your biggest money saver."

Another way trees help avert global warming is by the direct absorption of CO₂. The average tree absorbs about 4.5 kilograms of carbon dioxide from the atmosphere each year.

Trees in your neighbourhood provide many other environmental benefits. Trees absorb toxins such as ozone and sulfur dioxide, create a sound barrier against noise pollution, provide a habitat for birds and other animals, who in turn control insect populations, and intercept rainfall, reducing peak flood flows in the storm sewer system.¹²

Temperature Setting

Turn it down! Reduce unnecessary heating of the home with a set-back or programmable thermostat. It can save you up to 5% of your annual heating bill.¹³ That's about 250 kg in carbon dioxide savings based on Canada's average CO₂ emissions from home heating.

Suggested Temperature Settings

21 °C (70 °F) when relaxing

20 °C (68 °F) when working/exercising

18 °C (64 °F) when sleeping

16 °C (61 °F) when no-one is home

Increase humidity to improve the comfort level at lower temperatures.

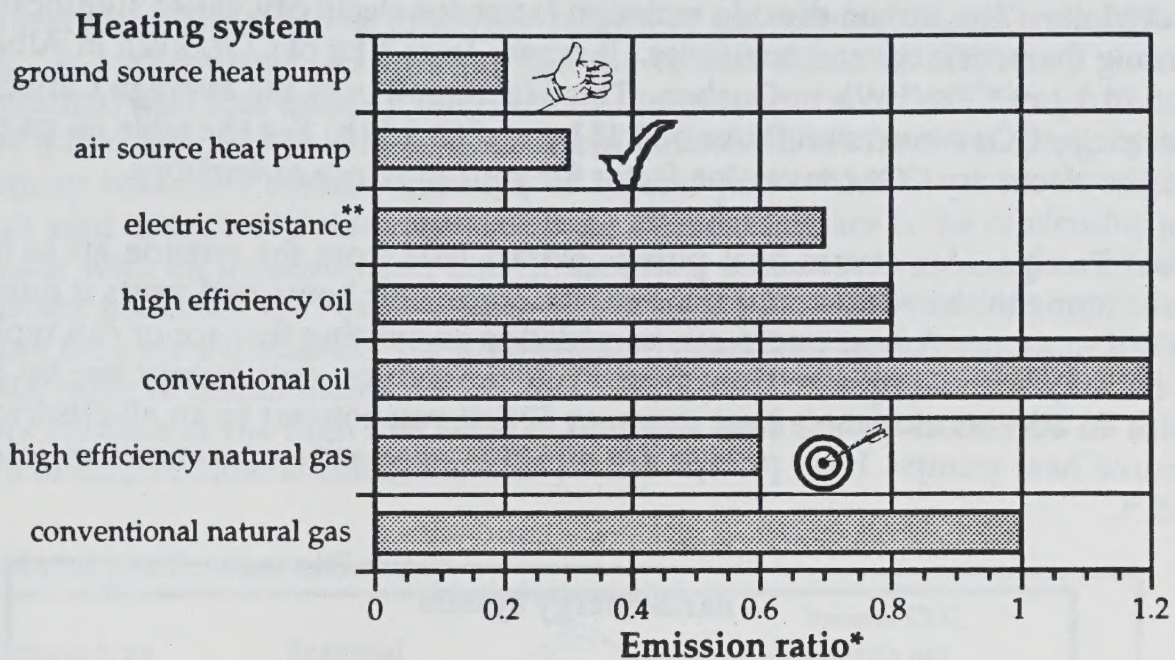
Heating Systems

A key factor to consider when choosing a heating system is the CO₂ intensity of different fuel types. Maximize the use of *renewable sources of energy*, such as solar or the Earth's heat extracted by heat pumps, which produce little or no CO₂ emissions.

¹²Friends of the Earth, 1992; City of Toronto Special Advisory Committee on the Environment, 1991.

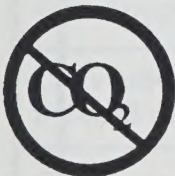
¹³Ontario Hydro, "Electricity use," 1991.

Comparison of CO₂ emissions from various home heating systems in Canada



*Relative to conventional natural gas heating system

**Based on Canada's average 1990 CO₂ emission rate of 0.22 kg of CO₂ per kilowatt hour



Passive Solar Design:

Passive solar avoids the greenhouse gas pollution resulting from conventional space heating, cooling and lighting methods.

Passive solar technology¹⁴ is a "design concept" featuring:

- sun facing windows
- the use of high performance windows
- the use of active mechanical ventilation to distribute and store solar heat
- the use of transparent insulation or use of solar dynamic walls
- envelope colour and texture

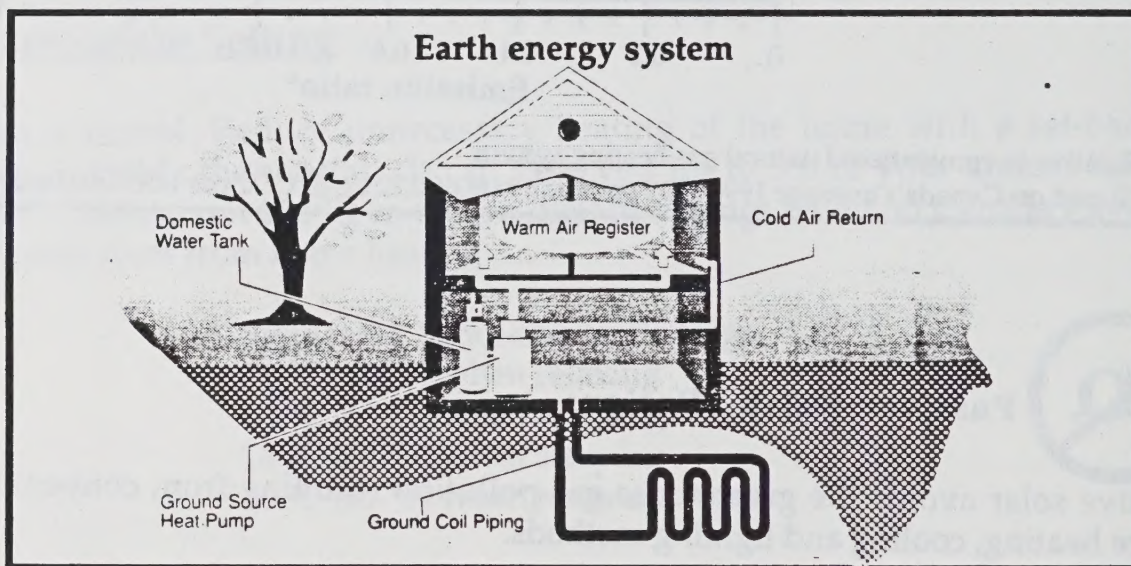
New houses and apartments can be built with high performance windows, thermal storage, and integrated mechanical systems to make them more efficient users of solar energy. According to a study commissioned by Energy, Mines and Resources, the use of passive solar design in new homes can achieve a solar

¹⁴Parekh and Platts, 1990

contribution to the heating load of about 25%.¹⁵ Currently, passive solar contributes only 4.4% to building space heating energy requirements in Canada.¹⁶

Electricity. The carbon dioxide emission factor for electricity varies significantly among the provinces and territories. It ranges from 1 kg of CO₂/kWh in Alberta to 0.01 kg of CO₂/kWh in Quebec. This Handbook uses the average Canadian electricity CO₂ conversion factor of **0.22 kg of CO₂/kWh**. See the table on page 13 for the electricity CO₂ conversion factor for your province or territory.

Heat Pumps. Air source heat pumps extract heat from the outside air to heat your home in the winter, and remove heat from your home and vent it outside in the summer. A heat pump can be added to an existing furnace or can replace it entirely with an all-electric system. You can reduce your energy use by 30% with an add-on air source heat pump or 50% if you convert to an all-electric air source heat pump. Heat pumps are effective even at temperatures as low as -15 °C.



Source: Ontario Ministry of Energy, *Home Heating & Cooling: A Consumer Guide* (1991)

Ground source heat pumps, also called Earth energy systems, use a renewable resource--the Earth's natural heat. An Earth energy system uses a heat pump to remove heat from the Earth or ground water in cold weather and transfers it to the house through an outdoor underground piping system. It saves 50% more than air source heat pumps since the temperature of the ground is higher in winter than air temperatures.

¹⁵Ibid., p19

¹⁶Ibid., pp. 12-13.

From a global warming perspective, Earth energy systems come out on top: they reduce energy consumption by 65% compared with oil or electric furnaces or 50% for a high efficiency gas furnace.¹⁷

Natural Gas. The seasonal efficiency ratings of gas furnaces range from 50% to 95%. A *conventional* gas furnace has the lowest seasonal efficiency due to substantial heat loss through the chimney. Improved conventional gas furnaces have a *vent damper*, which prevents warm household air from escaping up the chimney when the burner turns off, or *induced fans* which force air through a small vent instead of a chimney. The most efficient furnace is the *condensing* gas furnace with an induced draft fan. It uses heat exchangers made of corrosive-resistant materials that extract most of the heat in the combustion byproduct before they are exhausted. The high efficiency condensing furnace costs \$800 to \$1,400 more to install than a conventional furnace, but the payback time is 4 to 7 years because of the high fuel savings plus you save the environment 1.5 to 1.9 ton's of carbon dioxide emissions each year.¹⁸

Natural gas furnace efficiency

Furnace type	Seasonal efficiency (%)	Fuel savings (%)	Annual CO2 savings per household (kg)
Conventional*	50-60	base	base
Conventional with vent damper	63-70	5-15	300-900
Conventional with induced draft fan	70-80	15-20	900-1,200
Condensing with induced draft fan	85-95	30-37	1,800-2,250

Based on Energy, Mines and Resources, "Heating with Natural Gas," (1986)

*Average national emissions for gas furnaces are 6,100 kg of CO₂/household

Oil. The seasonal efficiency ratings of oil furnaces similarly range from 60% to 95%. You can upgrade a *conventional* oil furnace by installing an *automatic flue damper* to prevent heat from escaping up the chimney. Also, adding a *flame retention head burner* significantly improves combustion. A *mid-efficiency* furnace has a better combustion chamber of ceramic fibre or stainless steel, and an improved heat exchanger which extracts more heat from the hot combustion gases. The most efficient model is the *condensing* oil furnace which uses an extra

¹⁷Energy, Mines and Resources, "heating and Cooling with a Heat Pump," 1990.

¹⁸Jessica Thompson, *Mechanisms for Reducing Carbon Dioxide Emissions in Canada* (Environment Canada, 1991) citing Ontario Ministry of Energy, *The Shape of Ontario's Energy Demand 2000*, 1985.

heat exchanger to extract most of the heat from the combustion gases and causes most of the water vapour to condense inside the heat exchanger. The condensing oil furnace requires no chimney and uses a small vent instead.

Oil furnace efficiency

Furnace type	Seasonal efficiency (%)	Fuel savings (%)	Annual CO2 savings per household (kg)
Conventional*	60	base	base
• Plus automatic flue damper	62-68	3-11	250-900
• Plus flame retention burner	67-75	10-20	800-1,600
Medium efficiency	75-82	20-32	1,600-2,800
Condensing	85-95	29-37	2,300-3,000
Conventional with condensing add-on	85-95	29-37	2,300-3,000

Based on Energy, Mines and Resources, "Heating with Oil." (1988)

*Average national emissions for oil furnaces are 8,000 kg of CO₂/household

Furnace Tune-up. Keep your furnace or boiler operating at peak efficiency with a regular tune-up. Oil heating systems should be serviced annually while the cleaner gas burning systems need to be serviced every two years. Ask your serviceperson for the efficiency rating of your heating system before and after the tune-up. Each percentage gain in energy efficiency from the tune-up results in a proportionally greater reduction in CO₂ emissions from home heating.

Summer Cooling

The main sources of heat during summer are solar gain through windows, heat gain from the attic and internal gain from appliances and lights.

- plant deciduous trees to provide shade for your attic and windows
- shade windows with awnings, wooden louvres, and other devices
- improve attic insulation and ventilation (for every 300 square feet of attic floor area, there should be 1 square foot of unobstructed cross ventilation from end to end and from bottom to top of the attic space)
- fans are efficient methods of summer cooling
- look for energy efficient window air conditioning (calculate the wattage of the unit by multiplying amps x voltage)

3. Water Heating

Be a greenhouse gas miser and a water miser at the same time! Water heating is the largest home energy user after space heating, and accounts for 14% of the average home energy bill.¹⁹

Energy efficient showerhead. Replacing a standard showerhead (with a flow rate of 14.3 litres/minute) with an energy efficient showerhead (flow rate less than 11 litres/minute) may be the single most effective water conservation measure you can take inside your home. For a household that altogether takes 16 minutes worth of showers each day, a low flow showerhead can save 30,000 litres of water each year, plus 900 kilowatt hours required to heat the water, and reduce annual carbon dioxide emissions by about 200 kilograms (350 kg for gas water heaters; 450 kg for oil water heaters). While a low flow showerhead costs as little as \$10 it can save \$79 annually in water and energy savings.²⁰

Washing clothes. One quarter of your hot water use is for laundry. Whenever possible, wash clothes in warm or cold water. Rinse in cold water--it does not affect the cleanliness of the wash.

Energy efficient hot water tanks. Improve the energy efficiency of your hot water tank by getting an insulating blanket and pipe insulation. Wrap pipe insulation around the first 1 or 2 metres of hot water pipe from your water heater. Putting an insulating blanket around your hot water tank can reduce energy use by 10% and save 100 to 200 kg of CO₂ emission a year (180-350 kg of CO₂ for gas water heaters; 330-450 kg for oil water heaters).²¹ Also, flush your water heater regularly to prevent corrosion and calcium deposits from reducing the unit's efficiency.

Temperature Setting. Try setting your water heater to 54 °C though a setting of 60 °C is recommended for homes with dishwashers that use preheated water.

Water heating systems.

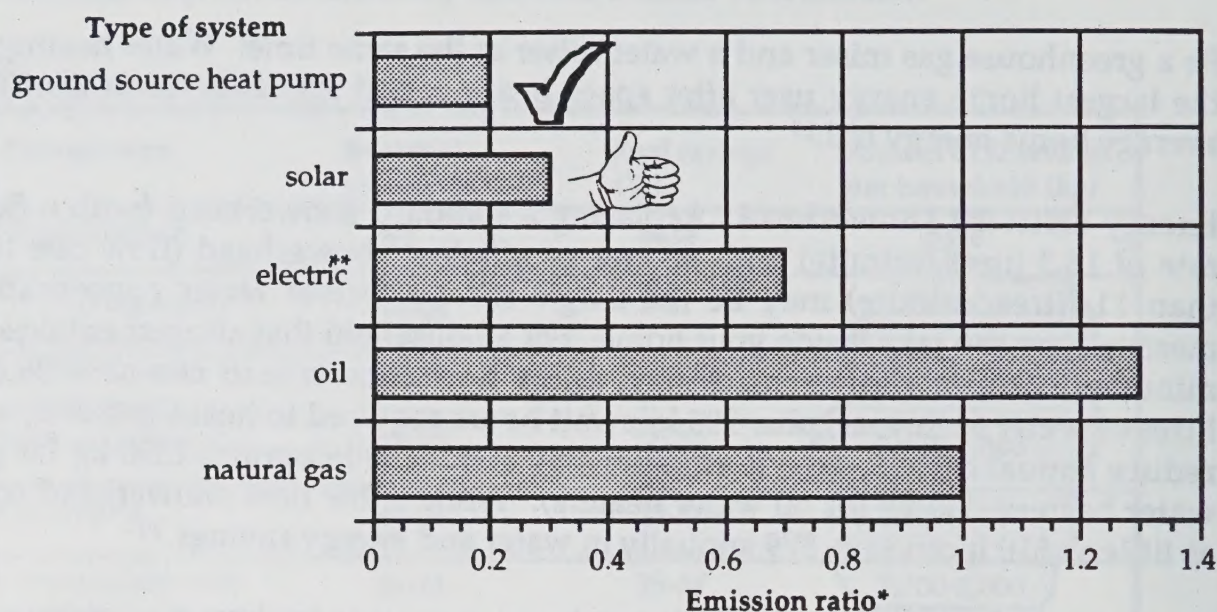
The figure below compares the CO₂ emissions from various water heating systems. The best choices from a greenhouse gas miser's perspective are the heat pump water heater and solar water heater. They use less than half the energy of conventional water heaters.

¹⁹National Energy Board, *Canadian Energy: Supply and Demand 1990-2010* (Ottawa, Minister of Supply and Services Canada, 1991).

²⁰This paragraph is based on Ontario Hydro, "How to save energy by using your showerhead," 1992.

²¹Jessica Thompson, 1991, p. 86

Comparison of CO₂ emissions from various water heating systems



*Relative to a natural gas system

**Chart assumes the electricity CO₂ emission rate is Canada's 1990 average = 0.22 kg of CO₂ per kilowatt hour

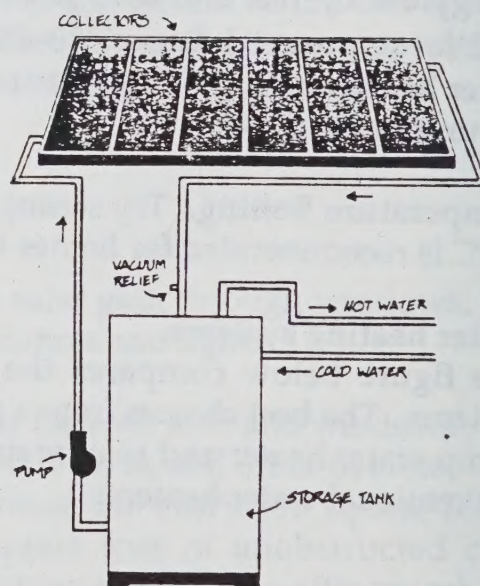


Solar water heaters

Solar water heaters use the sun's energy to provide domestic hot water. They can provide between 35% and 75% of your hot water needs, depending on their Solarguide rating. The Canadian Solar Industries Association rates solar water heaters based on their size, type, number of collectors and other design features.

You can also use active solar heat technology to heat swimming pools.

Source: Energy, Mines and Resources, Solar Water Heaters: A Buyer's Guide (Ottawa, Minister of Supply and Services Canada, 1986), pp. 8-9.

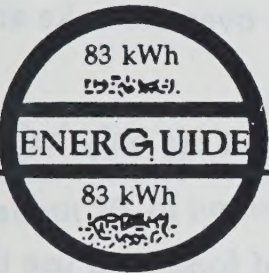


Active Solar Hot Water Heating System

Solar Energy Society of Canada Inc.
Canada ReNews (Summer 1990)

4. Appliances

Appliances consume about 15% of the total energy used in your home.²² When shopping for major appliances look for the Energuide label inside the appliance. The chart below illustrates the enormous CO₂ savings and reduced electric costs of operating energy efficient appliances compared to the electric guzzlers.



Comparative CO₂ and money savings of buying an energy efficient appliance versus an inefficient one

Appliance	refrigerator	freezer	range	dishwasher	clothes washer	clothes dryer
High efficiency (kWh/month)	73	42	62	93	50	81
Low efficiency (kWh/month)	145	82	75	121	128	111
Lifetime of appliance (years)	17	21	18	13	14	18
Lifetime energy savings (high - low efficiency)	\$1,175	\$806	\$225	\$474	\$1048	\$518
Annual carbon dioxide savings (kg)	190	106	34	74	206	79
Lifetime carbon dioxide savings (kg)	3,231	2,218	618	961	2,883	1,426

Chart based on electricity rate of 8¢ per kilowatt hour and Canada's average 1990 CO₂ emissions rate of 0.22 kg of CO₂ per kilowatt hour. See Energy, Mines and Resources, "Consumer's guide to buying energy efficient appliances and lighting," 1990.

Refrigerators. The recommended temperature setting for the refrigerator compartment is about 3°C and for the freezer section -18°C. For each 1°C temperature setting colder than necessary, the unit's energy consumption increases by about 2-3% and increases annual CO₂ emissions between 5 and 10 kg, depending on the efficiency of your unit. Also, experiment with the "energy saver" switch in your refrigerator - it allows you to adjust the heating coil under the "skin" of the refrigerator (the purpose of the heating coils is to prevent condensation on your refrigerator). Consider turning off the butter conditioner

²²National Energy Board, *Canadian Energy: Supply and Demand 1990-2010* (Ottawa, Minister of Supply and Services Canada, 1991).

since it is a little heater inside your refrigerator. Regularly clean dust off the refrigerator coils to prevent an efficiency reduction of the unit.

Freezers. The efficiencies of freezers, like refrigerators, vary by a factor of 2. A chest freezer is more efficient than an upright one since it is better at retaining the cold air.

Ranges. Look for ovens that are well insulated with tightly fitting doors. Self-cleaning ovens tend to be better insulated and thus more efficient. Convection ovens improve efficiency by using a fan to increase the flow over the bake and broil elements.

- Microwave ovens use half the energy of traditional ovens, but are only half as efficient as the stove top elements.

- The most energy efficient way of cooking small amounts of food is to use the microwave oven, toaster oven, slow cooker or induction cooktops. A slow cooker, for example, uses up to 80% less energy than would be required to cook the same food on the range. Also, electric kettles use half the energy required to heat water on a cooktop. Turn ovens and stove top elements before cooking is done and let the waste heat finish the job.

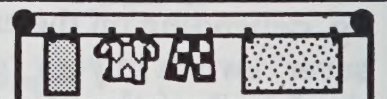
Dishwashers. Energy efficient dishwashers have a short cycle or econo wash switch which uses less hot water. 80% of the energy a dishwasher uses is to heat the water. They also have an energy-saver switch which allows you to turn off the electric-dry portion of the dishwasher and air dry your dishes at no CO₂ cost. If your dishwasher does not have the energy-saver switch simply turn off the dishwasher at the end of the rinse cycle and open the door to let the dishes air dry.

Clothes washers. As shown in the chart above, the most efficient washers use less than half the energy of the least efficient ones. The front loading washers tend to be much more energy efficient. Also look for a clothes washer that has a temperature control feature for cold wash and rinse cycles and a "sud saver" feature to save hot water. Rinsing and washing in cold water, and reusing wash water through successive washes is the most energy efficient way to do laundry.

Dryers.



Solar powered clothes dryer



Capture the outdoor freshness. Hang your clothes on the clothes line and let the sun and wind dry your clothes.

A distant second best choice is getting an energy efficient *heat pump clothes dryer*. They will soon be available in North America. Heat pump clothes dryers save 30-40% of energy - that's about 500 kg of CO₂ - and have the added conveniences of "no static cling, no fire risk, reduced abrasion of clothing, no overheating of delicate material and no vent."²³ Also, look for clothes dryers with features such as an electronic moisture sensor that turns off the machine when the clothes are dry and a cool-down cycle which tumbles clothes in cooler air during the last 5 to 10 minutes of operation.

5. Lighting

There are 30 to 50 light fixtures in the average home. Together they consume about 2% of home energy use (or 8% of the average home owner's electricity bill).

- **Switch to compact fluorescent lighting--the greenhouse gas miser's favourite.** Compact fluorescent light bulbs use about 20-30% of the energy consumed by regular incandescent lights. A compact fluorescent can cost 20 times as much as a regular bulb but it lasts ten times longer and more than pays for itself in energy savings.

How much can you save by replacing a standard incandescent with a compact fluorescent? The chart below shows that a compact fluorescent saves 125 kg of CO₂ and \$32.60 over its lifetime!

Comparative CO₂ and energy savings of buying compact fluorescent versus incandescent light bulbs

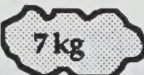
	 18 watt compact fluorescent	 75 watt incandescent light bulb
Light output	1,100 lumens	1,020 lumens
Cost of bulb	\$23.00	\$1.00
Product life	10,000 hours	1,000 hours
Annual CO ₂ emissions (assuming bulb used 5 hours/day)	 7 kg	 30 kg
Annual energy cost	\$2.63	\$10.95
Bulbs replaced in 5 years	0	10
Total CO ₂ savings over life	125 kg	---
Acid rain reduction		---
Total cost saving over life	\$32.60	---

Chart based on power costs of \$0.08 per kilowatt hour, and Canada's 1990 carbon dioxide emissions rate of 0.22 kg of CO₂ per kilowatt hour

²³Ontario Hydro, "A power saver's guide to choosing and using appliances," 1992.

- **Use halogen lamps.** Halogen lamps use 40-50% less energy than standard incandescents plus they last twice as long. 45 and 90 watt halogen lamps replace standard 75 and 150 watt spot and flood lights respectively. They are ideal for places where fluorescents bulbs are not suitable (e.g., with dimmers).
- **If you must, use energy efficient incandescent bulbs.** Energy efficient incandescents save a bit of energy compared to regular incandescents. They are available in 34, 52, 90, and 135 watts replacing 40, 60, 100, and 150 regular incandescent respectively. A cautionary note on "long life incandescents": they last up to 2-3 times longer but use up to 30% more energy than regular incandescents.
- **Turn it off!** It pays to turn the lights off even when you leave the room for a short time.
- **Minimize the number of light bulbs.** One 100 watt bulb gives off as much light as six 25 watt bulbs, saving 50 watts of energy and reducing waste as fewer bulbs need to be thrown away into landfills.
- **Use energy efficient security lighting** such as motion sensors and timers. A motion sensor using a 45 watt halogen light may be set off 6 times an evening for say 10 minutes each time. Annually, it would consume 16 kWh in electricity and result in the release of 4 kg of CO₂. Leaving a 100 watt incandescent light bulb on all day, on the other hand, would use 876 kWh and produce 193 kg of CO₂.

6. Waste Reduction

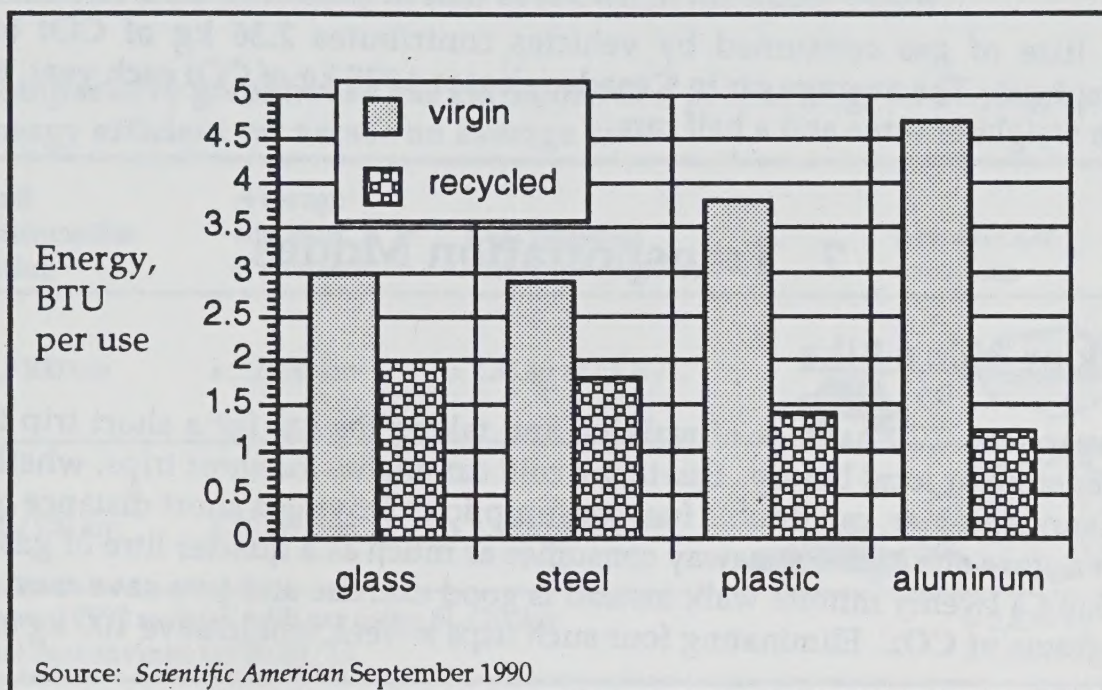
Reduce, Reuse and Recycle.

- **Reduce paper consumption.** The average Canadian uses 193 kg of paper each year compared to 1 kg for the average Chinese.²⁴
- **Reuse paper.** Share the daily newspaper. Circulate reports instead of making 1 copy/person. Read magazines and journals at the library. Use scrap paper for note-taking.
- **Recycle paper.** Recycled paper requires up to 50% less energy to produce. Every ton of recycled paper saves up to 19 trees.²⁵

²⁴Recycling Council of Ontario, "The office guide to waste reduction and recycling," 1991.

²⁵Ibid.

- One ton of aluminum produced from recycled cans rather than primary metal uses 2/3 less energy. It also avoids the production and release of 1.8 kg of halon gases equivalent to 15 tonnes of CO₂.
- Similar energy savings are achieved from recycling glass, steel and plastic as shown in the figure below.



Compost

By composting your food scraps and yard debris you can reduce your garbage output by one third and help reduce methane emissions from landfills (currently there are 66 kilograms of methane emissions per tonne of garbage). To avoid methane emissions make sure your composter uses aerobic decomposition. You can aerate your compost pile by poking it now and then.

By composting you also reduce the need for chemical fertilizers whose manufacture and use also emit greenhouse gases. Nitrogen fertilizer use, for example, accounts for 25% of Canada's total nitrous oxide (N₂O) emissions, a potent greenhouse gas.

Be a Greenhouse Gas Miser on the Road!

One third of Canada's carbon dioxide emissions come from the transportation sector along with 31% of nitrous oxide (N₂O). Canada's 13 million automobiles and light trucks account for half the CO₂ emissions from the transportation sector.

Each litre of gas consumed by vehicles contributes 2.36 kg of CO₂ to the atmosphere. The average car in Canada releases 4,925 kg of CO₂ each year, equal to the weight of three and a half cars.

7. Transportation Modes

Walk or Ride a Bike

Compare the CO₂ savings of walking and taking the car for a short trip to the corner store or local library. Starting a cold car engine for short trips, whether in winter or summer, can double fuel consumption. Driving a short distance to and from a store one kilometre away consumes as much as a quarter litre of gasoline. Walking a twenty minute walk instead is good exercise and **you save more than 500 grams of CO₂**. Eliminating four such trips a week would save 100 kg of CO₂ each year.

Mass Transit

- A single driver in a car produces about 8 times as much CO₂ per person kilometre as a rider on public transit.
- Take an intercity bus or train instead of driving alone.
- For short distances rail and bus are more efficient modes than aviation.

Carpool

- Instead of driving alone in a car, set up a carpool with your co-workers, neighbours and friends. Each new carpool saves an average of 2000 litres of gasoline a year.²⁶ **That's equal to 4,720 kg of CO₂!** Carpooling also pays in terms of dollars saved on gas, reduced wear-and-tear, and lower insurance fees.

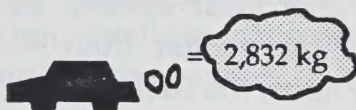
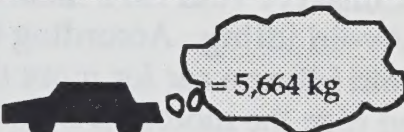
²⁶Ontario Ministry of Transportation and Communication and Ontario Ministry of Energy, "Share-A-Ride: Carpool," no date)

8. The Automobile

Buying a New Car

• When purchasing a new car, look for a fuel efficient model. The average fuel efficiency of cars in Canada is 12 litres per 100 kilometres. For new cars, it's 8.7 L/100km. Buying a car with a fuel efficiency of 6 L/100 km can cut your automobile CO₂ emissions in half as shown in the figure below.

Comparative greenhouse gas emissions and fuel savings of buying an energy efficient car versus an average car

Fuel consumption rating	Average distance travelled	CO ₂ emission factor for gasoline	Annual CO ₂ emissions
6 L/100 km	x 20,000 km	x 2.36 kg of CO ₂ /L	 = 2,832 kg
12 L/100 km	x 20,000 km	x 2.36 kg of CO ₂ /L	 = 5,664 kg
Annual CO ₂ savings with car using 6L/100km			= 2,832 kg
Fuel cost savings (at \$0.55/L)			= \$660.00

• More efficient vehicles tend to weigh less, have smaller engines and other features such as fuel injection, cruise control, and energy-saver radial tires. Energy-saver radial tires, for example, are designed to be more inflated than regular radial tires in order to reduce rolling resistance and increase fuel efficiency.

• Try to avoid gas guzzler options such as a high performance engine, turbocharged V8 engine, 4-barrel carburetor on a V8 engine, four-wheel drive, sun roof, roof rack, power steering, and air conditioning.²⁷

Maintenance

- **Keep your vehicle well-tuned.** A poorly tuned car can decrease fuel economy by up to 10%.
- **Keep tires properly inflated.** Improper tire inflation wastes up to 5% on gas.

²⁷Energy, Mines and Resources, *The Car Economy Book*, 5th ed., 1991.

- **Remove snow tires in the spring.** Use of snow tires increases fuel consumption by up to 4%.
- **Use premium, multi-grade oil.** It can improve your car's fuel economy by up to 6% by reducing engine friction.
- **Remove unnecessary weight and reduce aerodynamic drag.** Every 45 kg of extra weight in your trunk consumes 1% more fuel. Remove roof racks when they are not in use. Even an empty roof rack increases wind resistance enough to increase fuel use on the highway by 1%.

Driving Habits

Transport Canada estimates that differences in driving style leads to a 20% variation in fuel consumption among drivers.²⁸

- **Watch your speed.** Most cars use about 10% more gas when driven at 100 km/hour rather than 90 km/hour. At speeds above the legal limit of 100 km/hour, the fuel loss is about 1% for each kilometre per hour increase in speed.
- **Conserve your car's momentum.**
- **Avoid idling.** According to the Canadian Automobile Association, you should avoid idling a car for more than 30 seconds when it starts (even in cold weather), and turn the motor off if the car will be stopped for more than 60 seconds.
- **Avoid bumpy roads.** Rough asphalt, pot holes and gravel increase fuel consumption by as much as 15-35%.
- **Minimize the use of car air conditioning.** Air conditioners can increase your fuel use by up to 10-12% in stop-and-go traffic and 3-4% at highway speeds. They also release ozone-depleting CFCs into the atmosphere. An alternative in stop-and-go traffic is to open windows or the sunroof, although this increases aerodynamic drag and fuel consumption. At higher speeds, open up your flow-through vents.

²⁸Transport Canada, 1992 *Fuel Consumption Guide*. 1992.

Be a Greenhouse Gas Miser at Work!

9. Office Building

Energy Audits

- **Get an energy audit.** Energy audits provide a detailed breakdown of energy use and a detailed estimate of costs and payback periods for recommended measures. They are conducted by either the local power utility or a private energy consultant.
- **Do not limit conservation measures to quick payback ones.** Many conservation measure will have a negative or low cost. But a payback of 2 to 10 years is still a good investment for your workplace and the environment.
- **Address the sick building syndrome.** Many energy efficient building suffer from "sick building syndrome" due to poor ventilation, overcrowding and the presence of indoor toxics. Address this problem by cutting the sources of indoor pollution, and improving ventilation with an air exchanger.

Heating

- **Use renewable sources of energy.** A ground source heat pump recovers heat from the Earth and can save up to 60% on heating and cooling energy use. The input of 1 unit of electricity can produce up to 3 units of heating (or cooling) energy. Solar water heating avoids any greenhouse gas emissions.
- **Plant trees around your building.** Trees act as winter windbreaks and provide summer shade and thereby save energy (refer to section 2 above). Leaves from deciduous trees also provide you with the carbon content needed for your office's composting heap (see below).
- **Improve the building's thermal envelope.** Reduce energy leakage with insulation, weather-proofing, and window film.
- **Adjust temperatures during periods when a building is not used.**

Motors

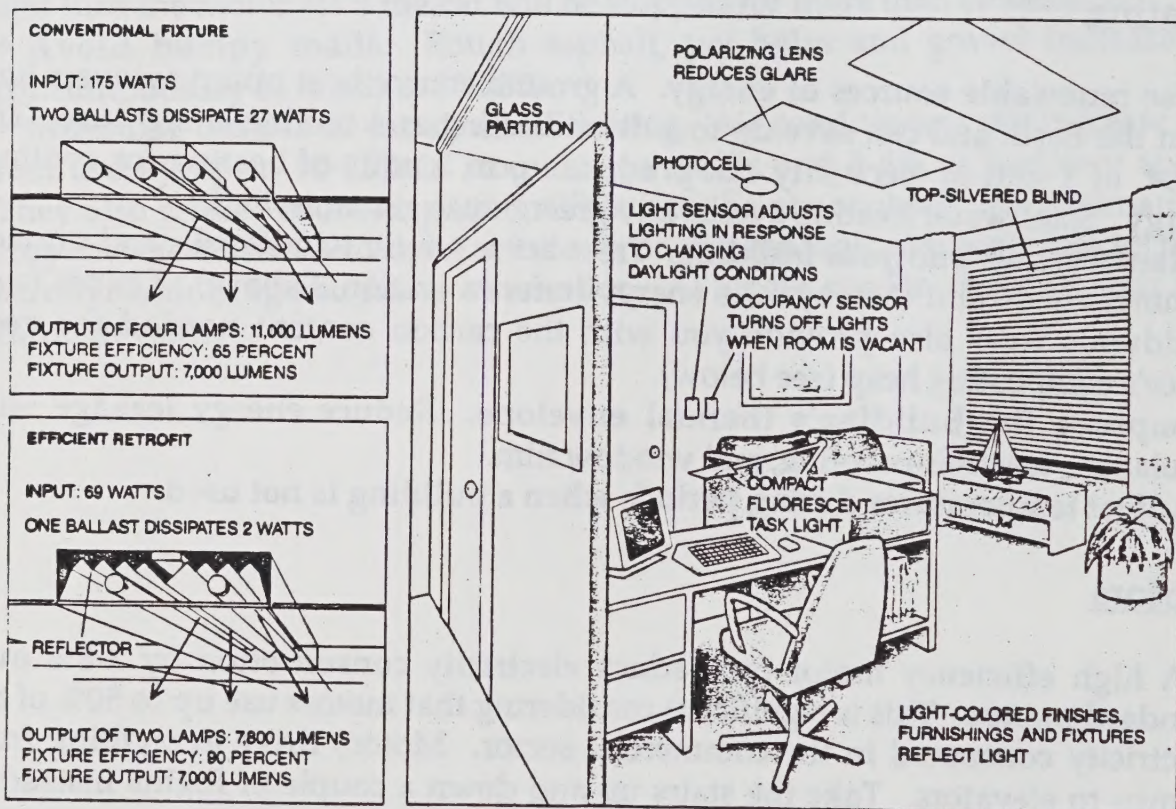
- **A high efficiency motor can reduce electricity consumption by 3-8% over standard motors.** This is significant considering that motors use up to 50% of the electricity consumed in the commercial sector. Motors drive everything from pumps to elevators. Take the stairs up and down a couple of flights instead of the elevator!

10. Work Station

Lighting

- **Use compact fluorescents in desk lamps.** Replace incandescent lamps with high-efficiency fluorescent lamps. Install more efficient lamp ballasts.
- **Use energy efficient fluorescents in overhead lights.** Retrofit existing fluorescent lighting systems with energy efficient fluorescent lamps, energy efficient ballasts or highly specular reflectors to reduce electricity use by 10-50% (see figure below). Replace T12 fluorescent with T8 fluorescent lighting systems and save 20-40% in electricity.²⁹
- **Replace "grid lighting" with "task lighting."** Switch from "grid lighting" where whole or large sections of floors of office buildings are lit up at the same time to "task lighting" where each office work station has its own lighting switches and controls
- **Install lighting control systems.** These include natural lighting control sensors that maximize use of daylight, occupancy sensors, small-scale computer timing devices.

A GHG miser's office (what a dream!):



SCIENTIFIC AMERICAN September 1990 67

²⁹This section is based on Ontario Hydro, "A program of energy cost-saving opportunities for Ontario industry," revised 1991.

Waste Reduction

- For tips on the 3Rs, see section 6 above.
- **Compost at the office!** Get an aerobic composting unit for your office and save valuable nutrients while avoiding methane emissions. If you prefer indoor composting, consider vermicomposting. If you have space outdoors and lots of trees, get a "soil saver" composting unit which requires a mix of nitrogen-rich food scraps with carbon-rich leaves. Compost food waste (e.g., coffee grounds, fruit and vegetable peelings, etc.). Compost food scraps from the cafeteria as well.

Use the compost for the flower gardens and lawn. It will save on CO₂ from the manufacture of chemical fertilizers and N₂O from the use of nitrogen fertilizers.

Office Equipment

- **Turn off your personal computer when not in use.** Do not leave your computer on all day. Most people use their computer a couple of hours a day and access their terminals 3 to 5 times per day.
- **Keep an inactive photocopier on power-saving mode.** When buying or renting a photocopier, look for one with a standby feature that puts the photocopier into an energy saving mode when not in use. Also a two-sided copying feature cuts your paper use in half!
- An inkjet printer uses up to 95% less energy than a laser printer while a dot matrix printer uses up to 75% less energy.
- A laptop consumes 90% less energy than a desktop model of equal computing power.

Purchasing

Always use lifecycle analysis before making major procurement decisions.

- Purchase energy efficient office equipment.
- Buy equipment and supplies made with recycled materials. If you're ordering office supplies or purchasing office furniture, make sure its made of recycled materials.

11. Work Related Travel

Alternative Transportation

- Encourage cycling, by installing a bike rack and shower facilities.
- **Provide employees with incentives to use public transit.**

- Hire a bicycle courier when possible.

Parking

- Provide free parking for employees in car pools.

Vehicle Requisition

- Consider shared use of vehicles before purchasing a new one.
- Purchase fuel-efficient vehicles.

Business Travel

- Avoid business travel by making increased use of teleconferencing
- Combine meetings in cities
- Use an intercity bus or train instead of an airplane for short distances
- Use buses instead of taxis
- Find a hotel close to your meeting location so your don't need a taxi

12. Community Action

Get informed. Read up on the global warming problem. See the reference list at the end of this publication for more details on actions you can take. Once you get informed share your knowledge with others. Make greenhouse gas actions contagious!

Join a local environmental group. Many environmental groups are involved in greenhouse gas projects, educational activities and lobbying efforts. See the *Green List*, published by the Canadian Environmental Network, for a list of environmental non-governmental organizations (ENGOS) indexed by issue and province.

Take action in your community. Get involved in tree planting. Initiate energy conservation projects at your local community centre. Set up a recycling program by getting in touch with the recycling council in your province or contact your municipal, provincial or federal waste reduction office.

If your community project requires funding, try to get sponsorship from your community centre or local business. Environment Canada's Environmental Partners Fund contributes up to 50% of the costs associated with community projects such as energy conservation and waste reduction (see reference at back for address).

Encourage environmental learning in schools.

Contact your municipal, provincial and federal politicians. Ask your elected representatives what they are doing to address the global warming problem. Share your ideas with them.

Link up with other communities. Find out what other communities are doing. Sponsor sustainable development projects in developing countries.

REFERENCES

Greenhouse Gas Miser Attitudes

Think Globally

- Grubb, Michael. "The greenhouse effect: negotiating targets," *International Affairs*. Vol. 66, No. 1, January 1990, pp. 67-89.
- Houghton, J. T., et al. (ed), *Climate Change: IPCC Scientific Assessment* (Cambridge: Cambridge University Press, 1990)
- World Commission on Environment and Development, *Our Common Future* (Oxford: Oxford University Press, 1987)
- World Resources Institute, *World Resources 1992-93* (Oxford: Oxford University Press, 1992)

Act Locally

- Statistics Canada, *Households and the Environment* (Minister of Industry, Science and Technology, 1992)

Linking Attitude and Actions

Conversion Factors

- Canadian Gas Association, *Canadian Residential Heating Survey* (1992)
- City of Toronto Special Advisory Committee on the Environment, *The Changing Atmosphere: Strategies for Reducing CO₂ Emissions: Technical Volume* (March 1991)
- DeCicco, John, James Cook, Dorene Bolze, and Jan Beyea, *CO₂ Diet for a Greenhouse Planet: A Citizen's Guide for Slowing Global Warming*. (National Audobon Society, 1990)
- Gilbert, Richard. "Activities related to the prevention of climate change in some major urban areas of North America." (Canadian Urban Institute, no date)
- Jacques, Art. *Greenhouse gas emissions: estimates for Canada*. (Ottawa: Environment Canada, Environment Protection, 1992)
- National Energy Board, *Canadian Energy: Supply and Demand 1990-2010* (1991)
- Ontario Global Warming Coalition, *Degrees of Change: Steps Towards an Ontario Global Warming Strategy* (Prepared for the Ontario Ministry of Energy and the Ontario Ministry of the Environment, June 1991)
- Ontario Ministry of Energy, *Home Heating and Cooling: A Consumer Guide* (1991)
- Statistics Canada, *Quarterly Energy Supply and Demand, 4th Quarter* (1990)
- Wiggins, E. J. and W. J. Yurko, "The Greenhouse Effect and the Alberta Fossil Fuels Industry: A Discussion Paper" (1989)

Greenhouse Gas Miser Actions

General

- DeCicco, John, James Cook, Dorene Bolze, and Jan Beyea, *CO₂ Diet for a Greenhouse Planet: A Citizen's Guide for Slowing Global Warming*. (National Audobon Society, 1990)
- Environment Canada, *What We Can Do For Our Environment: Hundreds of things to do now*, 4th ed. (Minister of Supply and Services Canada, 1991)
- Harmony Foundation of Canada, *Home and Family Guide: Practical Action for the Environment*.
- Johnson, Lorraine. *Green Future: How to Make a World of Difference*. (Markham: Penguin Books, 1990)
- Pollution Probe, *The Canadian Green Consumer's Guide: How You Can Help*, 2nd edition. (Toronto: McClelland and Stewart Inc., 1991)
- Rifkin, Jeremy. (ed) *The Green Lifestyle Handbook: 1001 ways you can heal the Earth* (New York: Henry Holt & Company, 1990)

Thompson, Jessica. *Mechanisms for Reducing Carbon Dioxide Emissions in Canada* (Environment Canada, 1991)

Be A Greenhouse Gas Miser At Home!

1. Selecting a Home

Energy, Mines and Resources, "Buying a new home? Is it R-2000?" (Minister of Supply and Services Canada, 1992)

—, *Consumer's Guide to Buying an R-2000 Home*. (Minister of Supply and Services Canada, 1991)

—, *Consumer's Guide to Buying an Energy-Efficient Resale Home*. (Minister of Supply and Services Canada, revised 1990)

Ontario Ministry of Energy, *The Advanced House*. (no date)

—, *R-2000 Design Handbook*, 3rd edition. (1990)

2. Home Heating and Cooling

General

Energy, Mines and Resources, *Consumer's Guide: Keeping the Heat In*. (Minister of Supply and Services Canada, 1990)

—, "Make Renovations Pay." (1988)

Ontario Ministry of Energy, *Home Heating and Cooling: A Consumer Guide*. (1991)

Draftproof and Insulate

Energy, Mines and Resources, "How to detect and seal air leaks." (1986)

—, "Caulking." (1986)

—, "Weatherstripping" (1986)

Windows and Doors

Energy, Mines and Resources, *Consumer's Guide to Buying Energy-Efficient Windows and Doors* (Minister of Supply and Services Canada 1989)

Plant Trees

Hashem Akbari and Haider Taha, *The Tree-House Effect: The Impact of Trees and White Surfaces on Residential Energy Use in Four Canadian Cities*. (Ottawa: Friends of the Earth, September 1991)

Friends of the Earth, "The Homeowner's Guide to Planting Energy Conservation Trees." (April 1992)

Heating Systems

Energy Mines and Resources, *Photovoltaic Systems: A Buyer's Guide*. (Minister of Supply and Services Canada, 1989)

—, *Passive Solar Potential in Canada: 1990-2010*. (Minister of Supply and Services Canada, 1990)

—, *Heating with Natural Gas*. (Minister of Supply and Services Canada, 1986)

—, *Heating with Electricity*. (Minister of Supply and Services Canada, revised 1988)

—, *Heating and Cooling with a Heat Pump*. (Minister of Supply and Services, revised 1990)

—, *Heating with Oil*. (Minister of Supply and Services Canada, revised 1988)

Summer Cooling

Ontario Hydro, "Wise ideas for efficient summer cooling" (no date)

3. Water Heating

Energy, Mines and Resources, *Solar Water Heaters: A Buyer's Guide*. (Minister of Supply and Services Canada, 1986)

Ontario Hydro, "How to Save Energy by Using Your Showerhead." (1992)

—, "Power Saver Ideas for Residential Water Heaters." (1992)

4. Appliances

Energy, Mines and Resources, *Energuide Directory: Energy Consumption Ratings of Appliances*. (Minister of Supply and Services Canada, 1991)

—, *Consumer's Guide to Buying Energy-Efficient Appliances and Lighting*. (Minister of Supply and Services, revised 1990)

5. Lighting

Energy, Mines and Resources, *Consumer's Guide to Buying Energy-Efficient Appliances and Lighting*. (Minister of Supply and Services, revised 1990)

Ontario Hydro, "Powerful Ideas on Energy Efficient Lighting." (1991)

6. Waste Reduction

Reduce, Reuse & Recycle

Isaacs, Colin. "Solid Waste: Out of Sight, Out of Mind," Chapter 25 in Government of Canada, *The State of Canada's Environment*. (Ottawa, 1991)

Compost

Cullen, Mark and Lorraine Johnson. *The Real Dirt: The Complete Guide to Backyard, Balcony and Apartment Composting*. (Toronto: Penguin Books, 1992)

Recycling Council of Ontario and the Metro Toronto Works Department, *Be Good to Your Garden: Compost!* (1991)

Be a Greenhouse Gas Miser on the Road!

7. Transportation Modes

Ontario Ministry of Transportation and Communications, "Share-A-Ride: Carpool." (no date)

8. The Automobile

Energy, Mines and Resources, *The Car Economy Book*, 5th ed. (Minister of Supply and Services Canada, 1991)

—, "Slow Down and Save! Driver's Tips for Energy Conservation." (no date)

—, "Alternative Transportation Fuels." (no date)

—, "Natural Gas for Vehicles." (Minister of Supply and Services Canada, 1991)

—, "Drive with Propane." (Minister of Supply and Services Canada, 1991)

Transport Canada, *1992 Fuel Consumption Guide: Ratings for new cars, pick-up trucks and vans*. (Minister of Supply and Services Canada, 1991)

Be a Greenhouse Gas Miser at Work!

Environment Canada, *Go Green at Work*. (1990)

Harmony Foundation, *Workplace Guide: Practical Action for the Environment* (1991)

Recycling Council of Ontario, "The Office Guide to Waste Reduction and Recycling." (no date)

Smith, Kirk, "Taking Charge of the Work Environment," in Jeremy Rifkin (ed), *Green Lifestyle Handbook* (New York: Henry Holt & Company, 1990)

Community Action

Environment Canada, *Ensemble: An Environmental Partners Fund newsletter*. (Available from Head Office, Environment Partners Fund, Ottawa, Ontario, K1A 0H3; telephone: 613/952 9448)

Elaine Rowan, Laura Torrible and Sandy Turner, *Green Communities: A Guide to Taking Action*. (Toronto: the Conservation Council of Ontario, 1992)

CA1 EP 2093G63

Canada. AES. Canadian Climate Centre. Greenhouse
Miser Committee.

GREENHOUSE GAS MISER HANDBOOK. / Krajnc, Ani
Hengeveld, Henry. 1993.

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